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ABSTRACT

This paper reviews the literature supporting a discovery- or inquiry-based learning approach to science and describes its benefits for students and teachers. The creation and evaluation of a website related to discovery-based learning is also described. (Contains 20 references.) (WRM)

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# The Use of a Web Site to Disperse Information on Discovery-Based Learning in Elementary Science Education

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Abstract

In the 1960s and 70s there was a trend to change the practices being implemented for the teaching of science to children. This trend spanned all grade levels from kindergarten to high school, and has been referred to in many different ways. Some researchers have called it discovery or inquiry-based learning, while others have called it constructivism or alphabet programs. All of these terms refer to inductive approaches used in science instruction. The ultimate goal of these new science programs is to change the traditional science curriculum and create a new curriculum. This new curriculum focuses on teaching students the processes and skills associated with science rather than the memorization of facts and information from science textbooks. It is hoped that through hands-on experience, students will gain a greater understanding of science. However, critics have argued that the new science curriculum is ineffective.

This paper provides a review of literature supporting this new approach to science and its benefits to both students and teachers. In addition, as a means of dispersing the information about discovery-based science programs to a larger number of teachers throughout the world, the researcher has chosen to create a Web site containing the information presented in this paper. The Web site contains additional informational links to resources available on the Internet, which may be useful to teachers in their science classrooms. It is hoped that many teachers looking for information about how to incorporate the new science curriculum into their classrooms will visit the Web site.

# The Use of an Educational Web Site to Disperse Information on the Need for Discovery Learning in Science Education

## Benefits of Discovery Learning Programs in Science

### What is discovery-based learning?

During the 1960's and 1970's there was an explosion in science education (Shymansky, Kyle, & Alport, 1983). This explosion was triggered by a desire to get students to experiment during science lessons. The desire was to have students exhibit the capabilities necessary to apply information presented by teachers and textbooks to experimental situations, and to exhibit the ability to generalize the information gathered from the experiment to real life situations. Thus, the explosion created new approaches to the presentation of science curriculum throughout classrooms from kindergarten up to high school. Eventually, these new approaches to science instruction were termed "alphabet soup" curriculums due to their abbreviated names (Shymansky et al., 1983, p. 388). The curriculum in these programs began to stress concepts in science that were not emphasized before.

The concepts in these programs focuses on assessing student's learning of science in terms of a broad conceptual framework while emphasizing science as a process. In this way, "The constructivist approach to teaching science...emphasizes the process through investigating rather than the 'teaching of science'. How scientific answers are found is called the process of science and what is discovered is known as the content" (Birse, 1996, p. 4). This new trend is to have students develop the skills necessary to apply scientific information in experimental situations and draw conclusions based on their observations and predictions. This approach is unusual because, "[It is] in contrast to traditional curricula which stressed facts, laws, theories, and some application" (Shymansky et al., 1983, p. 388).

These new "alphabet soup" science programs were eventually termed discovery based, inquiry based, or constructivist, science programs. In these new approaches, the teacher is no longer the center of instruction. The focus of learning shifts towards students' active manipulation and experimentation, which increases student activity while decreasing the teacher's instructional time. Bredderman (1982) notes that, "The amount of time devoted to student activity went from about 10 percent in traditional classrooms to about 19 percent in activity based classrooms" (p. 41). More student directed activity means that there is less use of lecture by the teacher (i.e., teacher-centered). The teacher is no longer seen as the sole possessor of all knowledge. In this way, "…the 'constructivist' approach is not teacher-centered, rather the teacher facilitates scientific investigation by using many different strategies" (Birse, 1996, p. 3).

The role of the student in discovery-based learning programs.

The realization that teachers should facilitate the learning of science, rather than instructing students directly, shifts the focus of instruction and places more responsibility in the hands of the students. Through the use of strategies, or instructional approaches, the students learn the skills of exploration, observation, manipulation of variables, questioning, and predicting. In other words, they take on the role of a scientist as they attempt to solve scientific problems. The effective use of these skills relies on the student's ability to get in touch with their senses. As stated by Birse (1996) "the emphasis is on the 'process' of science where children are encouraged to explore by using all of their senses rather than on book learning" (p. 3).

With a process orientation, students' role within the classroom is greatly changed. No longer are they expected to sit quietly in their seats reading science textbooks and answering questions, or listening carefully as the teacher explains numerous scientific laws and theories because the teacher is no longer the focus of the instruction. "The constructivist approach is not

teacher centered rather the teacher facilitates scientific investigation" (Birse, 1996, p. 4). In other words, the students are now asked to use their imaginations to created physical representations of events occurring in the everyday environment around them. Birse (1996) states, "Science...lessons are a vital part of a child's schooling since they basically provide children with a hands-on opportunity to investigate their world" (p. 4). Hands-on science lessons provided students with an atmosphere where they can actively manipulate materials in order to see the relationships between the objects and the environment.

Research conducted by Barman (1989) on discovery-based learning has found that the hands-on opportunities provided in this type of curriculum help students clarify misconceptions that they may have previously formulated. Barman (1989) states, "Researchers in this area have concluded that one of the reasons students develop these misconceptions is due to the way science concepts have been traditionally presented. They contend that in most science textbooks concepts are presented in only one context" (p. 7).

Barman's (1989) findings are important because they reveal that traditional textbook methods of instruction may actually reinforce students' misconceptions. However, a hands-on approach allows students to manipulate materials and observe the actual ways that objects relate to one another. In this way, students' concepts are either supported or rejected based on observations of the object's interactions with the environment. To further support Barman's (1989) findings Birse (1996) states, "When ideas can be proven or verified [through discovery-based learning] then children accept their findings" (p.4). Therefore, when concepts are rejected, the students have a concrete explanation of why which allows them to formulate a new logical conclusion and eliminate the prior misconception.

The new science curriculum requires students to engage with their peers and solve

problems. As stated by Hunn, Glasson, and Morse (1986), "the curriculum stressed the importance of group work...in classrooms" (p. 6). With a new emphasis on group work, students have a greater opportunity to utilize learning styles, which were not adequately addressed during lectures, textbook readings, and question/answer dittos. In this way, "emphasis...was also placed on encouraging teacher's to use children's natural curiosity and affinity for science. This interest is not always adequately measured by traditional paper and pencil worksheets or exams..." (Hunn et al., 1986, p. 5-6).

When students are engaged in discovery-based learning, they are being asked to work together in cooperative groups to combine observations and predictions. They are working together to test their predictions and draw conclusions. These new approaches increase the sharing of ideas. Through the sharing of ideas, students are helping one another gain the knowledge necessary to succeed in the science classroom. Barman (1989) states, "...cooperative learning's main focus is to provide experiences for students to help one another learn" (p. 11). Another benefit of discovery-based learning is that students are provided with a chance to work on their social interaction skills within the group by becoming active listeners. Birse (1996) notes, "Working in pairs is a useful strategy in a few ways. The children are more accountable. Listening skills are enhanced. Children can self assess and adopt different roles of questioner/listener" (p. 6).

Additionally, Barman (1989) reports similar findings, which support those noted above by Birse (1996). Through the use of cooperative groups in discovery-based learning, students are encouraged to help one another master the science material. "Students in small cooperative groups (2-4 students) learn more material, are more motivated to learn, and have more positive attitudes about learning than students who work alone or competitively" (Barman, 1989, p. 11).

These findings are important because cooperative learning is a key component in discovery-based learning. Students master the concepts by actively manipulating materials and formulating group hypotheses, or predictions. The students are responsible for ensuring that every member in the group masters the material and that all the ideas of each member in the group are discussed and recognized. Shimizu (1997) recognizes the benefits of cooperative group work in discovery-based learning activities by noting that students, "(1) contribute to the group's efforts and help others contribute; (2) support one's ideas by giving reasons; (3) work to understand other's ideas; (4) and to build on one another's ideas" (p. 6). Thus, by implementing discovery-based learning within the science curriculum, students may be gaining in both academic and social areas as they work together to master the content.

The role of the teacher in discovery-based learning.

The implementation of new science curriculums has resulted in a role change for the teacher. As was previously stated, the teacher's role has become that of facilitator for the observations, predictions and conclusions of the students (Birse, 1996). However, many teachers find the subject of science to be intimidating. Birse (1996) states, "Many primary teachers feel a lack of confidence in teaching science" (p. 6). Thus, many teachers have found their new role in discovery-based learning to be even more uncomfortable than their traditional role in science. In regards to teachers' feelings towards science, Hunn et al. (1986) state, "...they [teachers] feel inadequately prepared to teach science; equipment and supplies are rarely available; class time and concern are devoted almost exclusively to reading and mathematics instruction..." (p. 8-9).

When a teacher feels that she/he does not possess an adequate knowledge base or the necessary skills to teach specific content to students, they often rely on the textbook for assistance. Hunn et al. (1986) state, "...they lack the knowledge on innovative teaching strategies

and resources to improve science instruction" (p. 8-9). When a teacher does not feel comfortable teaching the science content, it is often difficult for them to implement a new instructional methodology in which they are facilitators rather than the transmitters of knowledge. In order for teachers to gain the confidence necessary to become facilitators during science lessons, they need preservice courses which, "...[expose them] to science experiences that link with pedagogy in order to enable [them] to become flexible in their thinking, receptive to change and innovation, questioning in their outlook, aware of their own perceptions and assumptions, open to a wide range of alternatives, tolerant of ambiguity, and reflective in their thinking" (Barr, 1994, p. 237). Discovery based learning, however, recognizes that elementary school teachers are not going to know everything about science. "No longer is the teacher's role one of giving information and facts. Teachers have become guides" (Birse, 1996, p. 6). Thus, new science curriculums stress teachers and students discovering together. Shimizu (1997) states, "teacher organization of the learning experience may limit or expand student opportunity to learn by emphasizing certain skills and knowledge..." (p. 4). The teacher is no longer imparting information on to the student. He/she is asking them to use their skills and their prior knowledge in order to make predictions about new material and make connections between similar situations already experienced and the new experience. Now, the teacher and the students are working together to learn about the things that they do not know.

It is must be emphasized here that discovery-based learning does not mean that the teacher is no longer active in the construction of lessons, organization of materials, and the presentation of knowledge to the students in the science class. In addition, it doesn't mean that the teacher is just allowing the students to have free time to explore the material or to learn lab skills. Shimizu (1997) states, "Although the development of lab skills may be a useful

component of scientific learning, it is not sufficient to develop student process skills" (p. 4). In discovery-based learning, the teacher is fostering the development of various skills. Some of these skills are, "...(1) identifying and defining pertinent variables; (2) interpreting, transforming, and analyzing data; (3) planning and designing an experiment; (4) formulating new hypotheses based on the result of their previous experiments; (5) defining the concepts on their own" (Shimizu, 1997, p. 5). In this way, the teacher must formulate activities that allow the students to practice these skills in a hands-on environment. The formulation of hands-on activities that effectively incorporate these types of skills is time consuming and requires the teacher to seriously consider the activities being used during the lesson. "No matter how teachers organize the learning experience, the organization itself becomes a significant source of learning opportunity for the student" (Shimizu, 1997, p.3).

Reports and findings on discovery-based learning.

Although the concepts and ideas stressed in these new science curriculums appear to be logical goals for each student in science, these programs have come under some scrutiny. For example, Gauger (1990) states, "Despite recent reform efforts including grants and programs that pursue excellence in science education, most schools continue to teach by lecture, textbook assignment and rote memorization" (p. 40).

With findings like Gauger's (1990), researchers are wondering just how effective discovery-based programs have really been in improving student performance. In some instances failure to see effective results with these programs have resulted in, "...major monies for continued development for science programs [being] withdrawn and public sentiment apparently favors a move back to the basics" (Shymansky et al., 1983, p. 388). However, should researchers and the public really be so quick to abandon such programs? The findings of some

researchers may make them rethink their decisions.

In December of 1990, Gauger reported findings that may suggest a long overdue revamping of science education for many classrooms. Gauger (1990) states, "By the third grade, 50% of our students have lost interest in science; by eighth grade only 20% choose to take science courses that are not required" (p. 39). These statistics suggest that if generations continue to turn away from science, there could be serious implications in the future. Advancements in technology, transportation, and communication will be hindered because there will not be enough scientists studying in these areas. In addition, environmental problems such as global warming, deforestation and ozone depletion will not be adequately addressed because there will not be enough people in the world who are scientifically literate to advise nations and people about which programs and preventive measures to implement (Gauger, 1990).

These findings are alarming and can not be ignored. Why is this happening? Why are students being turned off to science as early as the third grade? Gauger's (1990) research goes on to report, "Newsweek magazine recently concluded that our natural curiosity for science is extinguished through the perpetuation of archaic classroom exercises in memorization of scientific facts and formulas" (p. 39). Can traditional science curriculums be changed in such a way that they are beneficial to everyone? Is there a way that students can learn the facts while applying them to real life situations that allow them to use problems solving, prediction, and observation skills? Discovery based, or inquiry based, learning programs appear to be a logical answer to these questions.

The implementation of discovery-based programs in science classrooms has lead to improvements in many academic and social areas. Ramsey and Howe conducted an important study in 1969. Their research looked at the various types of instructional procedures

implemented in science classrooms. Their study revealed findings relevant to discovery-based programs versus traditional instruction programs. Ramsey and Howe (1969) state, "Achievement of content gains were strongly in favor of the problem-solving method [discovery-based learning] for teaching units..." (p. 28). The two researchers believed that achievement was higher in this group because the students were able to perform experiments and actively engage in the lesson. As a result, the students were better able to grasp the skills and concepts being taught. "Instructional procedures where the responsibility for the conceptual leap is placed upon the child, as in problem solving and inductive methods, do seem to bring about more significant achievement gains than do those methods where the teacher or the text material provides the concept" (Ramsey & Howe, 1969, p. 28).

Ramsey and Howe (1969) attribute the achievement of the students to the ability to manipulate materials. They state, "Pupils using the programmed materials learned concepts more efficiently than did those in classes taught in conventional ways" (p. 29). In this way, the students are manipulating the materials in order to gain a more concrete understanding of an abstract concept. Discovery-based methodologies use hands-on activities to reinforce the concept and make it easier for the student to see why the relationship exists. Thus, the findings of Ramsey and Howe (1969) show that discovery-based learning is effective in improving academic achievement.

In 1974, Johnson and Ryan conducted a study that looked at the implementation of discovery-based programs and their effects on the attitudes of students toward science. This study compared the attitudes of students who received discovery-based learning instruction against those who received traditional instruction. Traditional instruction refers to science curriculums in which there is a large focus on teacher lecture and textbook driven lessons. As a

result, Johnson and Ryan (1974) found that, "students dealing with materials [discovery-based method] to answer questions do develop more positive attitudes than those who do not [traditional instruction]" (p. 55).

The study by Johnson and Ryan (1974) attributed this finding to the instructional methodology used. The students receiving traditional instruction were more passive and, therefore, were not given a chance to develop a more positive attitude toward the material presented. However, the students receiving the discovery-based instruction were allowed to actively participate, through volunteering of questions and manipulation of materials, which allowed them to formulate opinions and attitudes toward the information presented. This finding is important because it shows that students' attitudes toward a subject can be influenced significantly by the method of instruction used by the teacher. In addition, it shows that discovery-based learning programs positively affect attitudes while Ramsey's and Howe's (1969) study shows that achievement is also improved.

To further support the findings of Ramsey and Howe (1969) and Johnson and Ryan (1974), another study by Shymansky et al. (1983) conducted an analysis of data that compared discovery-based learning programs to traditional instruction. The study analyzed the data and discovered that in addition to a positive effect on performance, "student attitude measures toward the subject specifically, science generally, and the new format of the courses (method) all resulted in exceptionally high positive effects" (Shymansky et al., 1983, p. 393). Other research also supports the findings of Shymansky et al. (1983) and Johnson and Ryan (1974). For example, Johnson, Ryan, and Schroeder (1974) found that, "It is clear from this study that...students who interacted with concrete materials...to answer questions developed significantly more positive attitudes than...students studying similar subject matter from a

textbook" (p. 55).

More recently, Kyle, Bonnstetter, McCloskey, and Fults' (1985) study revealed findings which continued to support the positive effects of discovery-based learning on students' attitudes. Kyle et al. (1985) report, "Research results presented in this article…show that the kind of classroom experience the students have in science can dramatically affect their perceptions of science and scientists and their attitude toward science" (p. 39). These researchers found that inquiry based learning caused an increase with which students rated science as their favorite subject. Kyle et al. (1985) state, "…43 percent of the SCIIS (Science Curriculum Improvement Study II) students [discovery-based program] chose science as their favorite or second favorite subject. Only 21 percent of the non-SCIIS [traditional instruction] students made such a choice" (p. 40).

These finding are very important because they reveal that students are finding science more interesting and enjoy science classrooms where they are able to manipulate material as a means of learning. In this way, students are developing a positive attitude about science. "Over 75 percent of SCIIS students find that science is fun, exciting and interesting and that it fosters a feeling of curiosity" (Kyle et al, 1985, p. 40).

In 1982, Bredderman conducted a study that also compared discovery-based learning to traditional classroom instructional methodologies. Bredderman's (1982) study reports the findings of over 13,000 students in 1,000 classrooms. His findings also support those reported by Ramsey and Howe (1969). He reports "…the evidence shows that children in classrooms where activity-based programs were used outperform those in comparison classrooms" (Bredderman, 1982, p. 39). Bredderman's findings are important because they show significant differences between the two instructional methods. For example, Bredderman's (1982) study

reports that students in the activity based programs performed 20 percentile units higher than students in the traditional program. In addition, his study finds that students instructed with discovery-based curriculums achieved significantly higher scores in the areas of creativity, attitude, perception, logic, and language development.

Bredderman's (1982) study also reports one unique finding. "Students who were disadvantaged, academically, economically, or both, gained more from activity-based programs than did students who were not disadvantaged learners" (p. 40). Bredderman (1982) goes on to say that disadvantaged students achieved 34 percentile units higher on tests than those in the traditional programs. These findings are significant for schools that contain a large number of poverty level, and learning disabled students because they reveal that implementation of discovery-based curriculums is beneficial in raising the academic achievement of these types of students in science.

Bredderman continued his research and in 1985 conducted a meta-analysis to evaluate the effects of discovery-based curricula on students' learning in elementary school. His study was based on 57 evaluation reports conducted on discovery-based learning programs. Findings from his data analysis revealed, "…the average student in experimental groups [discovery-based learning programs] performed as well as or better than 64% of the students in control groups [traditional instruction groups], an improvement of 14 percentile units" (Bredderman, 1985, p. 579). These findings support those of other researchers discussed above. In addition, Bredderman (1985) notes that implementation of discovery-based programs in elementary schools improves student performance in curriculum areas other than science.

Shymansky, Kyle and Alport conducted an important study in 1983. This study was important because it conducted a meta-analysis on data from "25 years of experimental and

quasi-experimental research regarding the question of curriculum impact on student performance" (p. 388). In this way, this study researched discovery-based learning programs that had been implemented over the past 25 years in order to assess their effectiveness. The findings are significant because of the breath and depth of the research study. This study looked at 302 pieces of research, which created a sample size of 45,626 students. In addition, the study looked at a variety of different topics studied in science. These topics ranged from elementary school curriculum to high school curriculum. For this paper, only those findings relevant to elementary school will be reported.

From their analysis, Shymansky et al. (1983) found that "...the new curricula has a positive impact on student performance..." (p. 392). This finding shows that the implementation of discovery based learning programs within schools is effectively teaching students skills and information relevant to science. Further data analysis by Shymansky et al. (1983) revealed that, "students exposed to new science curricula achieved 0.43 standard deviations above (exceeding 67% of the control group) or, nearly one-half of a grade level better than, their traditional curriculum counterparts on general achievement measures" (p. 392), which shows that not only is the program having a positive effect on student performance, it is significantly increasing it as compared to those students who are receiving traditional instruction.

In addition to the three findings stated above, the researchers found that students' higher cognitive skills such as critical thinking, problem solving, creativity, and logical thinking, were positively influenced by the new science curriculums (Shymansky et al., 1983). These findings show that discovery-based curricula are addressing skills that were not adequately addressed in the traditional instructional method. Development of these skills within the science curriculum is significant because the students become more like scientists. They are using skills that real

scientists use when conducting research.

In 1990, Shymansky, et al. re-synthesized the research they conducted in 1983 using a refined statistical procedure. The researchers conducted a reanalysis of the data because they wanted to see if their findings would remain consistent even when analyzed by more precise statistical measures. The reanalysis of the data found, "...students in the new science curricula outperformed their traditional program counterparts" (Shymansky, et al., 1990, p. 138). Shymansky et al. (1990) also go on to report that the new science programs (i.e. discovery-based learning) have a positive impact on students' general performance.

One interesting point that the researchers note is that, "...primary grade programs appear to have the greatest impact on student achievement and process skill development..." (Shymansky, et al., 1990, p. 138). Growth in the area of process skills in science class during the elementary school years is helpful in maintaining high performance and achievement level in science classes during the high school years. "Students develop their process skills and interest in science at the elementary grade level and then increased their achievement and continued their process skill development in later grades" (Shymansky, et al., 1990, p. 139).

The reanalysis also confirms previous findings of Shymansky, et al (1983) and Bredderman (1982) in regards to achievement in urban settings. The reanalysis reports that discovery-based learning programs increase these students' level of achievement in science classes. This may be important because many urban schools contain a variety of learning styles that appear to be adequately addressed through the implementation of these programs. "Considering the urban school student densities and the myriad of problems associated with inner-city teaching, it would seem foolish not to explore the components of these "new" science curricula that produced such positive gains" (Shymansky, et al., 1990, p. 141).

The current research has shown many positive effects associated with the implementation of discovery-based learning programs in elementary schools. The positive effects of these programs have been documented from the late 60s all the way to the present. In addition, the findings support the implementation in both urban and suburban school settings. Also there is evidence to support the premise that these programs are helpful with students who are economically disadvantaged. The programs have revealed positive effects in both the areas of achievement and social skills. It would appear that the implementation of these programs within elementary schools should continue due to their overall quality.

Creation of a Web site for Discovery Learning Programs in Science

Technology's place in the classroom today.

The tremendous advancements in the technology in the past ten years have resulted in a huge increase in the use and interaction of individuals with the computer. It appears that the use of computers during classroom instruction for students, and as an instructional resource for teachers, is beneficial. "Electronic interactive communications between students, educators and the world community offer exciting potential for gains in literacy, cultural, geographical, and socio-political understanding, preparation for the work force and democratization of society" (Andres, 1995a, p. 2). Not only has the use of computers increased in individual homes and companies, it has also found its place within school classrooms throughout the United States.

The advancement of computer technology within schools has been largely influenced by President Clinton's policy called Goals 2000 (Clinton, 1998). The intentions of the Goals 2000 policy are to have every classroom in the United States contain a computer, to develop students who are computer literate, and to have the teacher successfully integrate the use of the computer, as well as other technological mechanisms, into their classroom lessons.

The benefits of computer and the Internet for teachers and students.

The use of computers and the Internet is beneficial to both students and teachers. Students and teachers are able to access large amounts of information and resources faster than ever before. Reil (1996) states the benefits of the Internet clearly when she says, "The Internet is a place without physical boundaries. A place where people can go to meet people with similar interests, to build new settlements, to share knowledge through teaching and learning, and to form communities around common practices" (p. 1). In this way, many teachers will be able to access current information, quickly and efficiently, which will allow students to learn more.

The benefits of teachers retrieving information off of the Internet are numerous. One of the most relevant benefits is the tremendous amount of information available to teachers. They can find a wide array of resources such as books, stories, magazines, articles, and chat rooms just by clicking a mouse button. In addition, finding one resource often leads to the quick discovery of other related resources because many Web sites contain hyperlinks to other relevant sites. In this way, there is the potential for the teacher to utilize his/her time better because if they can efficiently search the Internet, they will be able to access a wealth of important and relevant information for the topics that they are teaching. This could potentially cut down on their research time. Hyperlinks can lead the teacher quickly to another relevant source.

A second benefit to the use of the Internet by teachers is the ability to communicate with one another quickly regardless of the distances between them. Riel (1996) states, "[The Internet] is a blend of projected reality with communication that makes it possible to create a sense of shared space with the potential for different forms of social exchanges" (p. 2). In this way, teachers around the world can share information with one another, and learn about one another's cultures and societies first hand.

The Internet creates a community of teachers who share information, lessons, and ideas. "Teachers need to be active and contributing members of communities of learners as a part of every school day and from within the classroom setting. It is the use of technology...that may reform education" (Riel, 1996, p. 4). Teachers must realize that there is a wealth of information waiting for them even after they receive their diploma. That wealth of information is accessible when teachers communicate with one another and share experiences, ideas and knowledge about teaching. "Communities of practice are people who share a collection of ideas, an activity, or a task" (Riel, 1996, p.3). Thus, the communities developed by teachers on the Internet foster development within their own classroom because they allow the exchange of a variety of ideas, lesson plans and new approaches to older concepts.

Teachers can exchange tremendous amounts of information through Internet communities. "These are marvelous tools that can...access information all over the world and bring multi-media into the classroom" (Andres, 1995, P.1). Teachers have a wealth of resources to choose from, which allows them to pick and choose what they would like to try in their classrooms. In addition, it provides them with the opportunity to modify information as needed to fit within their classroom, the students in the classroom, and the teacher's curriculum.

The Internet community can also be helpful to teachers because it can be a community that provides support and assistance to its members. Andres (1995b) states that the Internet promotes, "...the kinds of research and relationship experiences that help transform teachers into coaches, facilitators and side-by-side learners" (p. 1). In this way, teachers within the community can turn to one another when they are searching for information or activities for a unit in science or other curriculum areas. Members of the Internet community can provide assistance through suggestions and ideas, which may help the teacher formulate a stronger lesson

plan or activity for the students. Andres (1995b) personal experience with the Internet has allowed her to realize that it provides her with "a 'team' of experts volunteers right at [her] fingertips" (p. 2). The members within the Internet community are able to share a broader range of activities and information about science (and other areas) because the group is composed of many different people from all over the world.

Project Goals

All of the benefits mentioned within the review of literature support the dispersal of these findings on discovery-based learning curricula to teachers involved in science instruction at both the primary and secondary levels. In order to effectively raise the awareness level of teachers at all grade levels, a resource must be utilized which can be readily accessed by all. Currently, one of the most highly used informational resources is the Internet. The Internet is a technological advancement that allows information to be transmitted across towns, states, countries and continents. Not only does the Internet allow the information to reach a larger number of people, the information reaches them in a manner of minutes rather than days, weeks, months or years. With such an amazing resource available, it would be a shame not to utilize it. In this way, the project has opted to utilize the Internet for the reasons explained below.

Having the information available on the Internet allows for a greater number of people from around the world to access it. Therefore, a larger number of teachers may learn about this new curriculum for science. As the number of teachers aware of discovery-based learning increases, there may be more discussion about it. As the benefits are discussed, science teachers may begin to implement it in their classrooms. Some may use the Web site as a discussion group where they can talk to other teachers who have implemented the curriculum. They can discuss lessons they have taught, the positives of the program, how they went about implementing it and

any problems they may have encountered. As more teachers work together on discovery-based learning, a community network will be formed on the Internet, which fosters the exchange of ideas and allows the formation of a support network.

Therefore, one goal of this project is to have the Web site serve as a place where teachers can access the information, discuss it in order to weigh its positives and negatives, and gain support from those who are currently using it. In this way, knowing that someone is "out there" to help, encourages others to try something new (in this case, the discovery-based learning approach to science). Additionally, the web site increases the chance of reaching a larger number of teachers throughout the world because it spans a larger area than other informational resources.

Another benefit of having information on discovery-based learning on the Internet is that any updates, or new information, can be added quickly and the Web site modified in a timely manner. If the information were distributed via mail, any modifications to the publication would take much more time because it would have to be revised, reprinted and re-mailed. In addition, there is always the possibility that the current information will need to be modified again in a few months. The use of an Internet Web site provides easy modification access. Information can be changed weekly or monthly. The Internet is also cost-efficient because there is no need to pay for stamps or paper on which to mail out the information.

Thus, a second goal of the project is to create information that can be modified and updated as needed in order to keep teachers up to date with the latest news, research, and information on discovery-based learning. This will allow them to keep their programs up-to-date and effective. The Internet makes all of these things possible. Therefore, by creating a Web site on the Internet, a resource is provided to teachers which contains up-to-date and accurate

information.

Information presented on the Discovery Based Learning Web site is more visually appealing than information dispersed by mail. This is due to the fact that the information on the Internet is often presented using color, video, animation and audio. Information sent out by mail is normally black and white because color printing is extremely expensive, and because other technological advancements can not be easily included in a letter. However, by creating an Internet Web site, the use of technological advancements permits the presenter to use color, video, audio and animation as a means of disseminating the information. These technological advancements make informational presentations more eye appealing, more interesting, and are more likely to keep people focused and engaged on the information being presented. With a mail, presentation technological advancements can not be used, which may increase the chance that information sent to teachers may be thrown away without even being read.

## Method

### Participants

The sample was secondary education teachers in New York State who teach science in grades ninth through twelve, to students ages fourteen to seventeen. The number of participants in the sample was 34 teachers. All of the teachers selected are involved in a project called "Science on the Move". "Science on the Move" is a project run by Marist College, located in Poughkeepsie, N. Y., which receives funds from a National Science Foundation grant. The members of "Science on the Move" are teachers from multiple counties in the Hudson Valley region whose primary goal is to, "...integrate the most modern scientific instrumentation into laboratory experiments designed with a constructivist pedagogy" (DeGiglio, 1997, p. 1).

This sample was selected for a number of reasons. These teachers were selected because

they are familiar with discovery-based learning due to their involvement with the project, "Science on the Move". Secondly, they were selected because of their attempts to implement discovery-based programs within their own classrooms. In this way, they would be able to make recommendations about the effectiveness of implementing such programs earlier in school, such as in the elementary grades. Also, they would be able to assess whether or not the Web site is appropriate for elementary school teachers looking for information about discovery-based learning programs for science. Lastly, these teachers were selected because of convenience. Since the researcher is associated with Marist College and this group is part of the College, the researcher used them as the sample because they were easily accessible.

Since many of the teachers in "Science on the Move" are attempting to implement discovery-based learning programs into their own science classrooms, they would be able to evaluate the Internet Web site to make sure that it contains all the information necessary for teachers looking for information about implementation. Finally, they would be able to recommend information that needs to be added or modified within the Web site based on what they have learned from the Science on the Move program and their classroom experiences.

## Materials

A variety of materials were needed to complete the Web site. The computer used in the creation of the Web site was a Hewlett Packard. This computer had a 486 processor and a modem (28,800 bps), Windows 95 installed on it, and a CD-ROM drive. The researcher also had a dial account with an Internet Service provider. These were all of the requirements necessary to run the software program, Frontpage98 (Microsoft, 1998).

The software program selected to create the Web site was FrontPage98. This program

was selected for a number of reasons. One of the first reasons it was chosen was due to the high ratings that the software program received from *PC Magazine* (January 20, 1998) and *PC Plus Magazine* (February 9, 1997). In *PC Magazine* (1998), the author, Edward Mendelson recommended FrontPage98 because it gives the user, "...excellent control over creating a site with consistent look and feel" (p.3). In addition, Stephens of *PC Plus Magazine* (1997) states that FrontPage98, "...reveals itself as both powerful and easy to use. It's the best Windows-based Web site manager, by a clear margin, and especially good at handling multi-author projects" (p.2).

Another reason why FrontPage98 was selected is due to its format. Some programs for creating Web sites require that the user know HTML code. This code is a "...text-based markup language that forms the structure of the Web pages..." (Mendelson, 1998, p. 1). In other words, HTML code is a programming language used to make the Web pages found on the Internet look the way that they do. However, FrontPage98 does not require the user to know HTML code. Instead, the user selects items that they would like to use on their Web pages and the program automatically converts them into HTML code. This program, and others like it, is called a WYSIWYG editor, or "What You See Is What You Get" editor. A WYSIWYG editor, "...resembles a desktop publishing program more than a word processor (HTML code program)..." (Mendelson, 1998, p.1).

By selecting a WYSIGYG program, like FrontPage98, the creation of the Web site was much easier because there was no need to learn HTML code. This created a lowered frustration level for the creator of the Web site and allowed her to enjoy her first time experience of undertaking such a project. Mendelson (1998) notes, "...these programs are best suited to those wanting a great-looking site that's not very hard to build" (p.1).

Lastly, this program was selected because the creator of the Web site is very familiar with other software programs designed by Microsoft. This author's past experiences with Microsoft programs have contained little to no frustration. The programs are often well designed and extremely user friendly. In addition, the programs are often designed for people who are not computer wizards. This allows them to feel comfortable using the materials. Thus, the creator was confident that this software program would yield similar satisfactory results.

Other materials needed to conduct the survey (see Instruments, below) were computers with Internet access, the Web site address for the Web site being evaluated, and the informed consent. The actual wording of the informed consent can be found in Appendix A.

Instruments

The instrument to used in gathering information about the perceived effectiveness of this Web site was a survey. A copy of the survey can be found in Appendix B. The teachers were asked to access the Web site and answer questions in a survey regarding it. The survey was composed of 13 questions. The first four questions asked basic demographic information about the teachers. These four questions asked about their gender, their age, the number of years they have been teaching, the subject(s) they teach, and the grade level that they teach. This information was asked because the researcher would like to be able to accurately report the number of male and female teachers who participated in the survey, the average age of the group surveyed and the average number of years the group has been teaching. In addition, it would be good to know the various high school grade levels that were surveyed. This information was important because the type of feedback that the researcher receives may be influenced by the courses taught by the teachers that participated in the study.

The next nine questions asked specifically about the Web site in regards to its content and

appearance. The researcher asked about the appearance of the Web site because one of the reasons why it was created was because Web sites often provide more technological advancements which make them more colorful and eye catching than a black and white mailing to teachers. Thus, the researcher wanted to know whether or not the participants found the Web site attractive. If the site receives a low rating on attractiveness, then the researcher may want to consider adding more graphics and colors in order to make it more interesting and attractive to those accessing it.

The next two questions asked the participants whether or not they thought appropriate information was presented on discovery-based learning. These questions were appropriate because the whole purpose of the Web site is to provide teachers with a resource from which they can obtain adequate and concise information about a discovery-based learning program that they might want to implement in their classrooms. By asking teachers to evaluate the content presented on the program, the researcher can receive feedback from the teachers about it and make modifications in order to ensure that the Web site contains all the information necessary for those considering the implementation of the program into their classroom.

The next two questions involve the use of a Likert scale that is ipsative. Thus, the subjects are forced to make a choice because a "neutral" response is not offered. The researcher compose a 4 point Likert scale in which 4 = highly appropriate, 3 = appropriate, 2 = not very appropriate, and 1 = inappropriate. The researcher designed this scale because she wanted the subjects to seriously consider the information being presented and really think about it and assign it a rating that they believe truly explains how they feel about its quality.

The sample used a Liket scale (explained above) to rate the hyperlinks included in this Web site in order to provide the researcher with feedback about the quality of additional resource

information being provided to teachers. In addition, if these hyperlinks receive a poor rating, then it can logically be concluded that many teachers would not find the Web site to be a valuable resource because the links would not be accessed for further information. Thus, if the hyperlinks receive a low rating, the researcher will need to modify them in order to assure that the links being provided are resourceful for the audience who is going to be accessing them.

The participants were asked to use a Likert scale to rate the appropriateness of the lesson plans because the quality of these lesson plans will influence how many teachers will attempt to implement this program. As teachers access the Web site, those who are looking to implement a discovery-based learning program into their classroom, may want to begin by trying a few lessons before implementing the whole program. In this way, by providing the teachers with good lessons plans which are easy to follow and effectively implement discovery-based learning, teachers who are considering implementing the program, will be able to try a few lessons and see how they like them before making incorporating the whole program into their science curriculum. In addition, the participants can make suggestions to the researcher about other lessons that should be included or how the current lessons could be made even better.

The next question was important because it is the basis of the whole study. The researcher wants the participants to decide whether or not the Web site would be helpful to elementary school teachers. This question is key because the researcher believes that if discovery-based learning is implemented earlier in school, then students will be more interested in science and achieve more than they do now. In addition, by learning the processing strategies introduced in discovery-based learning, they will be more prepared for science courses in high school and college. The researcher asked the participants to suggest ways that the information of the Web site can be improved in order to provide more information to elementary school

teachers who are thinking about implementing the program.

The last question asked whether or not the participants believe many people would access the Web site. This question was asked because the researcher wants to keep the Web site updated with new information for teachers accessing it. However, if it is believed that not many people will be accessing this type of information, then the researcher will need to find another means of dispersing the information and put the Web site aside.

Procedure

On the day of the survey, July 22, 1998, the researcher informed the participants through the reading of the informed consent that their participation in this research project was completely voluntary. They were told that if at any time they felt uncomfortable or did not wish to proceed, they may stop. The researcher informed them of their rights as participants in the study. A copy of the wording of the informed consent can be found in Appendix A.

The researcher provided the participants in the sample with the address to the Web site. The subjects will be asked to review the Web site and, then, they were provided with a survey to evaluate it (A copy of the actual survey is located in Appendix B). The subjects were given an unlimited amount of time to look over the Web site and complete the survey.

The researcher reminded the participants not to write their names anywhere on the survey. The researcher asked the participants to place their completed survey in a manila envelope located in the back of the room when they finished in order to maintain confidentiality.

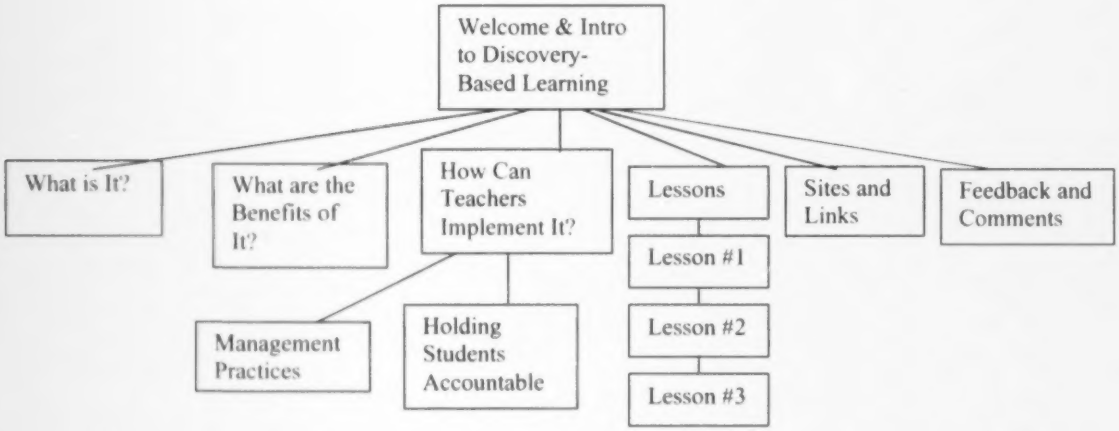
As the participants handed in their surveys, the researcher thanked them for their participation and through a debriefing notice (see Appendix C for wording), informed them that if they would like information about the results of the study they can contact the researcher or

her advisor.

## Design

### Web site design

The most efficient way to explain how the Web site was created was to use symbols to represent each page and the content on each page. The proposed design of the Web site is as follows:




On the "Welcome and Introduction to Discovery-Based Learning" page, the visitors to the Web site are welcomed and they are told what they can expect to find at the site. On the "What Is It?" page discovery-based learning is explained and some alternative terms for it are provided. On the "What are the Benefits of It?" page, the visitors are told the benefits associated with implementing a discovery-based learning program into their own classroom. The "How Can Teacher Implement" page is composed of two sections – "Management Practices" and "Holding Students Accountable". The "Management Practices" page discusses some management practices such as handouts and teacher preparation needed to have a successful



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program. The second page, "Holding Students Accountable", discusses how cooperative group work can be successful in a discovery-based learning program when a teacher sets clear expectations, assigns roles and uses assessment measures such as group grades and tests. The next four pages of the sites provide the visitor with a variety of lesson plans that may be implemented in a discovery-based learning classroom. The first lesson addresses the senses and has the students manipulate objects in order to learn about how their senses interact with one another. The second lesson is on condensation and it allows students to manipulate jars, water, ice cubes and other materials in order to learn about this concept. The last lesson addresses the concept of electricity. It has the students create a battery from wire and a lemon. The next page of the Web site is the "Sites and Links" page. Here the visitors are provided with sites and links to other locations on the web with lesson plans and interesting science topics. The last page of the Web site is the "Feedback" page. This section of the Web site provides visitors with the opportunity to email the creator of the site with suggestions and feedback.

Data Analysis and Discussion

The sample was composed of 34 subjects. Of these subjects 24 were male (70.6%) and 10 were female (29.4%). The subjects taught in a variety of grade levels ranging from seventh to twelfth with 9 teachers teaching science at two different grade levels. The average age of the teachers was 45 (SD=8.76), with one teacher failing to provide their age and two teachers giving their ages as 40+. (The researcher coded these two responses as 41 years old.) The youngest teacher in the sample was 26 and the oldest was 62. The average number of years that the teachers have been instructing in science was 17.8 (SD=8.82). The sample instructed on a wide variety of scientific topics. Seventeen of the teachers taught chemistry (50.0%), twelve of the teachers taught earth science (35.3%), ten of the teachers taught biology (29.4%), and nine of the

teachers taught physics (26.5%). It is important to note that the teachers taught in multiple disciplines, and, thus, the sample size (N=34) does not equal the number above (N=48) because some teachers instructing in more than one discipline were placed in all of the disciplines they taught.

The first question asked the subjects to rate the appearance of the Web site. An analysis of the Likert scale ratings revealed an overall rating of 4.14 (SD=.65) out of 5.0. The subjects were asked to use a Likert scale to rate the Web site's overall appearance. The highest rating that could be given was a 5 (highly attractive), while the lowest rating that could be given was a 1 (ugly). Thirty-three subjects rated the Web site's appearance. Out of this, 9 subjects gave it a 5 (highly attractive), 18 subjects gave it a 4 (attractive), 5 subjects gave it a 3 (OK), 1 subject rated it as a 3.5 (OK-attractive), and none of the subjects gave it a rating of 2 (not attractive) or 1 (ugly). Out of the 33 subjects 27 of them gave the Web site an overall appearance rating of either 5 (highly attractive) or 4 (attractive). Thus, the page received high marks from the subjects which shows that 81.8% (n=27) liked the set-up, the colors, the animation and the graphics used through out the site. However, it is important to note that two subjects noted that the color scheme used on some of the Web site pages was "a bit much"; meaning that too many colors were used on the page. One subject commented, "…[the] colors and stuff [are] a little overwhelming". Another subject stated, "Too many colors on a page" and pointed out that color is usually used to, "denote importance". In addition, 3 of the subjects noted that the Web site needed more diagrams, or visuals, with the lesson plans. One subject notes, "Multimedia clips could give classroom teachers greater confidence in establishing your ideas for their own use". In this way, the researcher may want to go back and modify some of the pages in order to tone the color scheme down some.

The subjects were asked whether or not the content provided at the Web site appropriately explains discovery-based learning. Thirty-four subjects answered the question. Thirty of them (88.2%) responded "yes", they believed the content explained discovery-based learning appropriately, while 4 (11.8%) responded "no". Three of the subjects had responded "no" because they felt that my definition of discovery-based learning was not totally correct and needed some modification. In hind site, the researcher feels that the question should have been phrased differently in order to elicit a more specific response from the subjects. The "yes/no" question did not provide the researcher with much information, or feedback, from the subjects.

The subjects were also asked to rate the hyperlinks provided on the Web site. The subjects were again asked to use a Likert scale to rate them. The highest rating was a 4 (very appropriate) and the lowest rating was a 1 (inappropriate). Thirty-three subjects responded to the question, giving the hyperlinks received a rating of 3.46 (SD=.58) out of 4.0. This rating breaks down into: 14 subjects providing a rating of 4 (very appropriate), 14 providing a rating of 3 (appropriate), 1 subject rating the hyperlinks as 2.5 (appropriate/not very appropriate), three subjects rating the hyperlinks as a 2 (not very appropriate) and 1 subject rating the hyperlinks as a 1 (inappropriate). One subject asked, "Can you add a fuller description of each site?". By explaining the available links on the Sites and Links page the visitor would know where they were heading prior to clicking on them. In addition, two of the subjects mentioned that the links should have been more age/grade appropriate (more focused on elementary school science topics). A subject commented, "…the cow eye dissection [hyperlink] – not age appropriate". Thus, the researcher will have to go into the Sites and Links page of the Internet Web site and provide more information on the sites provided. In addition, the sites should be modified in order to provided links that are more age appropriate.

The subjects were also asked to rate the lesson plans that were included at the Web site. The subjects were again asked to use a Likert scale to rate the lesson plans. The highest rating that could be given was a 4 (very appropriate) while the lowest rating that could be given was a 1 (inappropriate). The lesson plans received an overall rating of 3.28 (SD=.77) out of 4.0. Twenty-eight of the subjects (84.8%) felt that the lesson plans were either very appropriate (4), or appropriate (3). One subject felt that the lessons failed to appropriately display the concepts of discovery-based learning. The subject noted, "These experiments seem to be designed to elicit observations, but not the 'why' behind them". In addition, 4 other subjects felt that the lessons would not be appropriate for elementary school students and that the lesson plans should have included diagrams, or visuals, in order to explain the activities better. One subject mentioned the use of, "video clips in lesson plans for beginning teachers". While another subject commented, "Diagrams which teachers could download to help introduce these activities might be helpful". Therefore, the researcher believes that modification of the lesson plans is necessary to meet the suggestions and recommendations of the subjects. In addition, being that these high school teachers are making recommendations on a Web site aimed towards elementary school teachers, their recommendations that the lessons be modified in order to be more age appropriate is informative because the Web site is intended to provide information to elementary school teachers.

The subjects were asked whether or not the Web site would be helpful to elementary school teachers planning to implement a discovery-based learning program into their science lessons. Thirty-one subjects responded to the question. Out of the thirty-one subjects, twenty-nine responded "yes" to the question and two responded "no". Although 85.3% (n=29) of the sample replied that the Web site would be helpful, suggestions were made in order to make it

more appropriate. One subject suggested, "I would include more visuals that show how to set-up experiments, pictures of students in action, etc".

Lastly, the researcher sought feedback as to whether or not the subjects believed that many people would access the Web site. From the analysis the researcher found that 30 subjects had answered the question. Of these thirty subjects, 26 (76.5%) responded "yes", they believed the site would be accessed, and 4 (11.8%) responded "no". It is important to note that although 4 of the subjects did not answer the yes/no question, three of them and 4 of the subjects that answered "yes" to the question provided additional thoughts and comments about access to the site. The four subjects that responded "no" to the questions also made similar points. Three of the subjects wondered if this site would be brought up if a search engine (a type of database search finder on the Internet) was used to try and locate the site. One subject raised the questions, "Is the site a site that can be easily found using a search engine? How would a teacher find the site?" Another noted, "The site will have to be referenced in search engines and present as a link in major educational pages…". Two subjects wanted to know if it would be advertised so that people would know that the site was out there on the Internet. A subject questioned, "How will you advertise its [the Web site's] existence?". Two other subjects wondered if this would appear as a link on other peoples' Web sites. Lastly, two of the subjects felt that there may not be enough information at the site to have visitors come and access it more than once. A subject noted, "…not enough content to return, except for lesson plans (most important item on site)". Another commented, "Once they go to the lesson plans they will probably switch to sites that have much more material". All of these thoughts were helpful because they provided the researcher with thoughts that need to be addressed in order to make sure that the Web site reaches as many people as possible.

## Conclusion

Overall, the data analysis shows that the web site would be a good way to disperse information to elementary school teachers about discovery-based learning. The results have indicated that technology is a strong tool for dispersing information to a large quantity of people. This would seem rational because as we enter into the twentieth century, technology will play an even larger role in our lives than ever before. More people, and children, will be using technology in their every day lives. This can be seen more and more in schools where papers, homework and even tests can now be given by computer. Therefore, placing research on the Internet is a logical next step.

### Limitations

One of the major limitations of the research study is that the researcher did not use elementary school teachers to evaluate the web page. In this way, the researcher is lacking information from the population for whom the web page is intended for. The fact of the matter is that high school teachers do not really know what is taught at the elementary school level. They may have some basic understanding of how the science curriculum is structured, but they have never formulated lessons for this age group. However, the researcher felt that by having these experts evaluate the Web site they would be able to assess whether or not it provided all of the necessary components and information for teachers thinking about implementing such a program into their science curriculum.

Another limitation of the study is the sample size. The number of participants is low (N=30). In this way, the researcher must exhibit caution when attempting to generalize the results to a larger population of educators. In addition, because the sample is only taken from one geographic area within the United States and New York, the generalizability is limited only

to those groups of educators that have similar compositions to the one used in the sample.

A third limitation of the study is that not all teachers across the country have Internet access. Although the Internet is the wave of the future, not all teachers have the luxury of having Internet access within their classroom, or within their school. In this way, not all teachers will have access to the information presented on the Web site. Although the likelihood that the information will reach a much larger group of educators is increased, it is important that the researcher realize that not all teachers will have technological advancements provided to them.

Lastly, a final limitation to this study was that the researcher did not place the survey at the Web site on the Internet. If the survey had been place on the site, the researcher could elicit information not only from the group of teachers surveyed but from others that accessed the Web site. It may be conducive for the researcher to place the survey on the Web site sometime in the future in order to elicit more information from others, especially elementary school teachers.

Patterns in the Data Analysis

A close look at the data reveals some interesting findings. One of the most interesting findings is that the majority of teachers, 76.5%, believed that many people would access the Web site. In addition, although the majority believed that the site would be accessed, there were many questions about how the site would be found by people who were not given the address directly (like those who participated in the survey). In addition, the subjects raised questions about how the Web site would be advertised in order to let others know that it was out there on the Internet. These were important concerns to those who thought about people outside of this subject pool accessing the site.

Another predominant trend in the data was that the subjects became confused when too many colors were used. This was quite a surprise to the researcher, who believed that the more

color one uses in a piece of work, the more interesting and engaging it becomes for the subjects. On the contrary, using too much color actually bothered some of the subjects because they were not sure if the color change signified a hyperlink.

Lastly, a final pattern the researcher noted in the data analysis, was the request for pictures, diagrams and photos to accompany lesson plans and students engaged in discovery based learning. The analysis revealed that many of the subjects believed that these would be extremely helpful to those teachers beginning to implement this type of teaching methodology.

Future Research

Finally, future suggestions for the continued development of the Web site created are as follows: the researcher intends to have this site submitted to a number of search engines on the Internet. If the site is accepted by these search engines, the site will be put in their databases, which will allow it to pulled up when a search is conducted on discovery-based learning. Thus, if a person does not know the sites address, there is still the possibility that the site will be revisited.

In addition, the researcher hopes to modify/change the current lesson plans at the site and possibly add more lessons as time goes on. If the researcher is unable to add more lesson, the older lessons may be removed from the site and replaced with newer lessons. This will keep people visiting the site because there will be new material there. The researcher also hopes to do the same with the hyperlinks and sites provided to visitors. These will either be updated or added to. The researcher also hopes to make the lessons, the hyperlinks and the sites more age appropriate and to make clear what age group these things would be appropriate for.

Lastly, the researcher will change the color scheme in order to make it more eye-pleasing to visitors. This seemed to be a major complaint in the survey and it is one that should be

addressed by the researcher promptly in order to keep people coming to the site.

In closing, it is important to note that these things take time and that it is very hard to keep a Web site up to date constantly. However, a large effort will be made by the researcher to maintain the site for as long as possible.

website address: www.academic.marist.edu/discvryl/

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Appendix A

Informed Consent

Hello, my name is Stefanie Sardilli and I am student of the Community Systems Learning in a Diverse Society course. I am conducting a survey to evaluate a web page that I have designed for elementary school teachers about discovery-based learning programs in science. Due to the fact that all of you have implemented similar programs within your secondary education science classrooms, I am looking for your feedback on the design and content of the web page. In addition, I am looking for information on whether or not you believe that this web page will be beneficial to elementary school teachers who are thinking about implementing such a program into their own science curriculums.

Please take the time to answer all of the questions on the survey that apply to you. If you do not wish to continue to participate at any time during the survey, you can stop and no questions will be asked. Please do not write your name anywhere on the survey in order to ensure ambiguity and confidentiality. Thank you for your time. If you would like to know the results of this survey you can contact Dr. David Rule at 575-3000 ext. 2979 or 914-876-7829, or me at 914-276-3064.

Appendix B

The following is a survey being conducted for Community Systems Learning in a Diverse Society. Your participation is very much appreciated.

1. Please specify your gender (circle one) MALE FEMALE

2. Age:_____

3. How many years have you been teaching? _____

4. Please specify your current teaching assignments. Rank them in the order of your teaching load (i.e., number of sessions/periods) from the **most to the least**.

| Grade Level | Discipline (E.g., Biology) |
|---|---|
| | |
| | |
| | |
| | |

5. Rate the overall appearance of the Web site (5 being the highest; 1 being the lowest)

5 4 3 2 1

highly attractive attractive OK not attractive ugly

6. Do you believe the content on the pages appropriately explains discovery-based learning programs? (Circle one) YES NO

If you circled "no" please proceed to question #7. If you circled "yes" please move on to question #8.

7. What other content should be included on the Web site to more adequately explain discovery-based programs? Be specific:

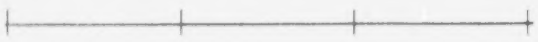
_____

_____

_____

8. Rate the hyperlinks at the web site in regards to their appropriateness to the content of the page.

(4 being the highest; 1 being the lowest)



4 3 2 1

Very Appropriate Appropriate Not Very Appropriate Inappropriate

9. Rate the appropriateness of the lesson plans included on the Web site (4 being the highest; 1 being the lowest)

4 3 2 1

Very Appropriate Appropriate Not Very Appropriate Inappropriate

10. Do you feel the information presented in the Web site will be helpful to elementary school teachers planning to implement discovery-based learning programs into their science lessons?

Please circle one: YES NO

If you circled "no" please proceed to question #11. If you circled "yes" please move on to question #12.

11. Please specify what changes need to be made to the Web site in order to make it appropriate for elementary school teachers beginning to implement the program in their science classrooms:

_____

_____

_____

_____

12. Do you feel that many people will access the Web site? Circle one: YES NO

If you circled "no" please proceed question #13. If you answered "yes", you have completed the survey. Thank you for your time and feedback.

13. If "no" please specify the reasons why you do not feel that many people will access the Web site: _____

_____

_____

_____

Thank you for your time and feedback.

Appendix C

Debriefing

Thank you for participating in the survey. The purpose of this study is to determine if the web page designed on discovery-based learning programs for science education is going to be an effective tool for elementary teachers who are trying to incorporate the program into their science curriculums. This results of this survey will be used to modify the web page and prepare it for access to educators throughout the world. If you would like to know the results of this survey you can contact:

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